I. ABSTRACT

Harvesting electrical energy from wind is considered a feasible solution for the issue of abundance energy. The performance key of wind turbine presents in blade design. Therefore, the referred design and optimization issue is concerned for vertical wind turbine blade made from composite material. Consequently, the research presents modelling and optimizing of a composite material blade for a vertical wind turbine. Furthermore, the approach deployed Genetic algorithm for finding optimum solution. Optimization decision parameters include reinforcement and matrix materials, fibre orientations, lamina thickness, and number of lamina for blade structure.

The approach aims to optimize blade design for aerodynamic loads, inertia load, and operating couples. Building an efficient genetic algorithm requires a significant representation to the phenomenon and an appropriate definition of the fitness function. Blade weight estimates each lamina mass in blade structure, then sum lamina mass to get the blade mass. Blade cost uses the data of lamina weight to estimate the cost of each lamina, then sum the lamina cost to get the blade cost. Material model predicates properties in principal directions. Force model analyzes all external force couple system. Stress and failure model evaluate all stress condition against material strength. Failure criterion determines acceptance of proposed model. All these parameters embedded into single fitness function. Eventually, the objective function decides whether this model would replace one of the preceding generation or not.

Research followed three strategies. First strategy concerns the single objective function to minimize the total mass of the blade. Second strategy minimizes the multi-objective function of weight and cost. Third strategy minimizes failure and mass as multi-objective function. The three strategies have two types of constraints; first type is integer parameters domain, second type is continues parameters relation. First type of constraints contains number of lamina, reinforcement index, and matrix index. User determines number of lamina. Reinforcement and matrix index depends on the number of materials for trade off. Second type of constraints contains relation for geometry shape and failure analysis. NACA four digits designation is the constraints relations for lamina thickness and core width. Tsai-Hill failure criterion is the limitation for the blade strength. Finally, a standalone application integrates all the research works, the application is programmed using Matlab software.